USGS
WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2005TN16B

Title: Macropores and Colloids: Their Influence on the Quantity and Quality of Recharge

Project Type: Research

Focus Categories: Water Quality, Water Quantity, Nutrients

Keywords: recharge, preferential flow, colloids, nutrients, water quality, macropore flow

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Congressional District: TN2

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Abstract

Research has identified a significant impact on water quality associated to the rapid transport of chemicals within unsaturated soil by the preferential flow of water. The transport of Phosphorous is of concern since it is generally the limiting nutrient in eutrophication of surface waters. Phosphorous is normally bound to immobile soil particles, but some charged soil particles called colloids can be mobile especially when preferential flow paths are present. The purpose of the proposed research is to define the role of preferential flow as it relates to the quantity and quality of water that infiltrates through the soil.

Founded in 1990, the Water Quality Research Unit at the Ames Plantation in west Tennessee has been conducting surface and subsurface water research. Multiple conservative tracer and herbicide transport tests conducted at the site have demonstrated the significant impact preferential flow paths have on the subsurface hydrology. The upper 1.5 m of the site is composed of uniform loess, or wind deposited soil. The loess

soil can be found throughout much of Western Tennessee, Western Mississippi and Eastern Arkansas. Previous experience at the Ames Plantation reveals that up to 90% of the groundwater recharge is due to preferential flow. Since the loess is heavily utilized for agriculture, the potential exists for rapid nutrient and pesticide loss to underlying aquifers and nearby streams. Typically, Phosphorous (P) is considered to be relatively immobile within the soils, but when macropores and/or colloids are present, P can also be mobile.

Eight intact soil monoliths with diameters of 0.30 m and lengths of 1.0 m will be excavated from Ames Plantation and transported to the Biosystems Engineering and Environmental Science departmental laboratory in Knoxville, Tennessee. Diammonium Phosphate will be applied to the surface of four monoliths, and poultry litter will be applied to the surface of the other four monoliths. Artificial rainfall spiked with Bromide, which will act as a conservative tracer, will be applied to the surface of all monoliths. Water that rapidly flows through macropores will be collected as it drips from the base of the monoliths. Suction lysimeters will be installed at various points along the length of the monoliths, which will enable sampling of the water that is flowing within the soil matrix under tension. The concentrations of P within the effluent will be analyzed, which will enable the comparison of P transport from inorganic and organic fertilizer, and from macropore and matrix flow. Additionally, a portion of the effluent will be filtered with 0.45, 0.2, or 0.02 ƒÝm nylon filters, to reveal the role colloids play in the transport of P. Because a water balance will be calculated throughout the experiment, the direct impact of macropores on water flow will be determined by analyzing the breakthrough curve of the Bromide as a function of the number of pore volumes of effluent collected. At the conclusion of the breakthrough phase of the study, dye will be applied to the columns. The dye will mark the macropore preferential flow paths. The columns will be dissected and the soil sampled for analysis of Bromide and P. These results will be used to determine the amount of interaction between the soil matrix and flow within the macropores.

This project will provide the support for a student pursuing a Master¡¦s of Science in Biosystems Engineering Technology. Two hourly undergraduate students will be employed to help with the laboratory analyses. Additionally, roughly 60 undergraduate engineering students will be exposed to the project as part of Dr. Tyner¡¦s Hydrology class, which will incorporate in-class laboratory assignments to help fulfill the research needs and educate future researchers.